

EVALUATION OF TOOTH RESTORATIONS MADE OF ZIRCONIA

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Project number: 491950_Cerec
Date of creation of report: January 2013

**ORDERING PARTY:
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Objective

Fracture toughnesses and microstructure were to be evaluated on the tooth restorations provided by the ordering party. The evaluation of the microstructure was to include the homogeneity of the microstructure as well as the particle size distribution.

The TZI and ZI materials provided by the ordering party are shown in fig. 1 and fig. 2. The black markings on the tooth restorations show the cross cuts (specified by the ordering party). For crowns (last column), the cross cuts (red line) could be selected at random.

Results

3.1

Fracture toughness according to Vickers

A Vickers indentation was performed at three measuring points on each restoration half. Fig. 8 and fig. 9 show examples of the measuring points used (M1 to M3). These measuring points were also used for the SEM scans to evaluate the microstructures and determine the particle sizes. The fracture toughness was determined in the IF procedure as per the Anstis method.

3.2

Microstructure scans and particle sizes

The microstructure scans for determining the particle size and distribution were produced with scanning electron microscopy. These were taken near to the Vickers indentations. Three scans were made of each tooth restoration sample. The TZI and ZI materials were each cauterized by passing them through a furnace.

Summary of TZI material

Normal sintering:

The fracture toughnesses of the samples sintered with the normal program are within the range from 2.99 ± 0.05 to 3.24 ± 0.06 . There is no significant difference between the values for crowns and connectors, except for sample 2326. As there were no other distinctive features of sample 2326 (e.g. particle size or homogeneity of the microstructure), it can be assumed that this is an outlier. It is possible to execute a repeat measurement. As a basic principle, statistics from 3 measurement values are only of limited value.

Speed 99 sintering:

It is necessary to declare an outlier from the measurement values (sample 242-6 crown). Without this value, the measurement values lie within the range 3.05 ± 0.12 to 3.25 ± 0.04 . The particle size distribution is also unremarkable here. Measurements could be repeated to improve the statistics if necessary.

Super Speed sintering:

The measurement values are within the range 3.09 ± 0.1 to 3.34 ± 0.2 , including those from the V 9/2012 report.

Comparison of the individual sintering programs:

No significant differences were found when comparing the sintering programs with each other. The fracture toughness value for tooth restoration 242-6 crown is somewhat outside of the range, but with three measurement values, the statistics are only of limited value. Additional measurements would have been required to strengthen the statistics.

Summary of ZI material

Normal sintering:

The fracture toughnesses of the samples sintered with the Normal program are in the range 3.30 ± 0.05 to 3.45 ± 0.11 for the bridge connectors and 3.41 ± 0.05 to 3.72 ± 0.15 for the crowns. It is worth noting that the two measurement values with the highest fracture toughness values show a higher distribution. It appears that higher values and simultaneously higher distribution can be achieved for crowns. A statistic from three measurement values is only of limited value. Additional measurements should be performed to strengthen the statistic values.

Speed 99 sintering:

The fracture toughnesses for the Speed 99 program are in the range 3.20 ± 0.05 to 3.39 ± 0.18 for the bridge connectors and 3.41 ± 0.02 to 3.44 ± 0.08 for the crowns. The measurement values for the fracture toughnesses are very close to one another.

Super Speed sintering:

The fracture toughnesses for the Super Speed program are in the range 3.20 ± 0.11 to 3.41 ± 0.06

Comparison of the individual sintering programs:

It is worth noting that the high measurement values have a considerably larger distribution than the lower measurement values.

Excluding the measurement values for the crowns with the largest distribution, comparing the Normal and Speed 99 programs gives equally large values.

The fracture toughness values are to some extent somewhat smaller for the Super Speed program. Lower results are to be achieved for the bridge connectors than for the crowns.

The bridge connectors tend to show smaller fracture toughness values than the crowns.
